

## **REMARKS/ARGUMENTS**

### **Claims Status**

Claims 1-25 remain in this application. Claims 10 and 23 have been amended. Claims 1-9 and 18-23 have been withdrawn as a result of an earlier restriction requirement. In view of the examiner's earlier restriction requirement, applicant retains the right to present claims 1-9 and 18-21 in a divisional application.

**Claims 10-16 and 23-25 are rejected under 35 USC 103(a) as being unpatentable over US Patent Publication 2001/0044043 (Badding) in view of US Patent 4,272,353 (Lawrance).**

Claim 10 calls for a solid oxide electrode/electrolyte assembly comprising an electrolyte sheet that "has a surface with a pre-determined embossed or molded bi-axial pattern and a thickness variation of at least 2 micrometers and its thickness variation is 6.6% to 90% of the average electrolyte sheet thickness."

The thickness variation of 6.6% to 90% is not disclosed, nor suggested by either of the two cited references. Thus, because the references, in combination, do not disclose all of the features of claim 10 and its dependent claims 11-16, claims 10-16 are not obvious over the cited references.

In addition, the Badding reference discloses a solid oxide fuel cell device with silver based electrodes that include a ceramic phase (see paragraphs [0027], [0034]) and a ceramic electrolyte sheet (see paragraph [0040]) with an roughened interface layer (paragraphs [0043] and [0053]). The reference discloses that the roughened interface layer was provided to reduce interfacial resistance ( **NOT electrolyte sheet resistance**) between the electrodes and electrolyte and/or to improve the adherence of the electrode to electrolyte (paragraphs [0043] and [0053]). The reference teaches that the disclosed

interface layer has a roughened surface which is provided by “applying rough nano-crystalline surface layers to opposite surfaces of the electrolyte”. That is, the disclosed surface variation, required to achieve the purpose of the Badding reference is measured in nanometers, and is not “of at least 2 micrometers” as claimed in claim 10. (A nanometer is  $10^{-9}$  m, or 0.01  $\mu\text{m}$ ). Thus, the thickness variation of Badding is MUCH smaller than the claimed 6.6% to 90% of the average electrolyte sheet thickness.

It is known that a thicker electrolyte layer would increase electrolyte's ohmic resistance. The Badding reference itself teaches that that electrolyte sheet resistance is proportional to its thickness (paragraph [0041]). Thus, the Badding reference utilizes a thin interfacial layer, with small surface variation (i.e., nanometer(s), due to nano-crystalline structure), which improves adhesion, but does not significantly adds to the electrolyte sheet resistance. In addition, because this thin interfacial layer is applied by tape casting a ceramic slip (by applying fluid suspension of yttria-partially stabilized zirconia) (see paragraphs [0053] and [0054]), the surface variations disclosed by Badding are completely random, without a pre-determined pattern. Moreover, no predetermine pattern is needed to achieve the purpose of Badding.

The Badding reference discloses solid oxide fuel cell devices based on silver based electrodes and a thin ceramic electrolyte sheets. The Lawrence reference utilizes different materials for electrolytes (polymer plastics) and for electrodes (carbon based electrodes), thus the adhesion properties of these materials are different from that of those material required for solid oxide fuel cells. There is no expectation, nor teaching that the surface variation of Lawrence will improve adhesion between the different materials utilized by Badding. Furthermore, since the roughened interfacial surface of Badding reference achieves its desired purpose, there is no incentive to modify it with the surface Lawrence. It is not taught or suggested in either of the two reference (nor would it have been obvious to one of skill in the art of solid oxide fuel cells) that 6  $\mu\text{m}$  deep surface scratches, taught by Lawrence, would have provided a better adherence

between the silver based electrodes to the ceramic electrolyte sheet of Badding, than what have been provided by the smaller variations in the roughened layer of Badding.

Secondly, a typical polymer membrane thickness is about 200-250  $\mu\text{m}$ . For example, the Lawrence reference itself discloses a polymer membrane with a thickness of 10 mils. Thus, a 6  $\mu\text{m}$  surface variation of Lawrence corresponds to a very small fraction (about 3% or less) of the Lawrence's electrolyte sheet thickness, which is much smaller than the one claimed by the applicants. The Lawrence-reference does not teach, nor suggests "thickness variation is 6.6% to 90% of the average electrolyte sheet thickness "claimed by claim 10, or "that the thickness variation is at least 10% of the average electrolyte sheet thickness" as specified in claim 12. There is no teaching or suggestion in the Lawrence reference of utilizing the 6  $\mu\text{m}$  deep scratches (see Lawrence, col. 6, lns. 8-45.) on thin electrolyte sheets of less than 45  $\mu\text{m}$  (e.g., 3-20  $\mu\text{m}$ ) taught by Badding.

In fact, applying the sanding (the) the method taught by Lawrence (sanding) to the thin ceramic electrolyte sheet of Badding would have likely to have torn the fragile electrolyte sheet of Badding, making it unusable. The Lawrence reference itself suggest that patterning the surface by other means does not work (col. 2, lns. 43-52) and that only abrasion works (col. 2, lns. 43-47) well, and that care should be taken during sanding so as not to shred or mutilate the (relatively thick) polymer membrane (see col.6, lns. 50-55). The Lawrence reference does not suggest that this sanding method will work for electrolytes made of different (ceramic, more fragile) electrolytes, which are also much thinner (<45 $\mu\text{m}$ ) then the typical plastic polymer electrolytes. Thus, one of skill in the art would have no expectation of success in applying the teachings of Lawrence to that of Badding.

Applicant's amended claim 10 to state that the electrolyte sheet surface has a predetermined pattern, which is reproducible. That is the pattern can be reproduced on

another electrolyte sheet. The Lawrence reference does not result in a predetermined pattern, because one does not know before hand the exact locations on a surface of the polymer membrane where the scratches would appear (since one can not predict sandblasting results, or precisely where the grit particles (from sanding) will come in contact with the electrolyte sheet) Thus, although the Lawrence reference teaches that the sanding in two directions will result in scratches that are oriented in these directions, the Lawrence reference does not teach how to produce a pre-determined pattern, nor enables someone to make the pattern re-producible (repeatable). In contrast, a surface pattern that results from, for example, embossing or molding as described in Applicants' specification, is pre-determined. That is, one knows before hand the exact features of the pattern, and these features can be replicated on other electrolyte sheets.

Applicants' purpose was different from that of Lawrence and Badding. Applicants tried to improve the ohmic resistance of the electrolyte sheet, while improving the surface adhesion between the solid oxide electrolyte sheet and its electrodes. Thus, applicants departed from the nano crystalline layer of Badding and instead claimed an electrolyte sheet surface with a thickness variation of at least 2 micrometers and relatively large surface variation of 6.6% to 90% of the average electrolyte sheet thickness.

Accordingly, claims 10 -16 are not obvious over the cited references.

With regard to ohmic resistance (claims 23-25) the Office Action stated that it is an inherent feature of the materials and design. However, since applicant's claimed a different design than the one disclosed by Badding (no nanocrystalline layer, larger relative surface variation), and Lawrence (which discloses much thicker electrolyte sheet than what is claimed by Applicants and shows relatively small surface variations—i.e., about 3% or less of the average polymer electrolyte thickness (6  $\mu\text{m}$  on a 200-250  $\mu\text{m}$  thick electrolyte sheet.)

**Claims 10-16 and 23-24 are rejected under 35 USC 103(a) as being unpatentable over US Patent Publication 2003/0180602 (Finn).**

The Finn reference teaches away from the Applicant's invention. The Finn reference specifically teaches that thickness variations are less than 5%, and more preferably less than 1% of the electrolyte sheet thickness. This was done to improve surface adhesion for SOFC electrolytes. However, Applicants are claiming larger ratio of surface variations (up to 90 %), which is outside the range disclosed by the cited reference, because they are also improving electrolyte sheet's ohmic resistance- which is a new and different result not taught or suggested by the Finn reference.

The Office Action (pg. 6) stated that the claimed ranges, which do not overlap prior art ranges, are unpatentable, unless they produced a new and different result, which is different in kind and not merely in degree from the Prior Art (MPEP 2144.08). Applicants are solving a different problem and produce a different result-they are reducing the electrolyte sheet's ohmic resistance, while simultaneously improving its adherence to electrodes. They achieve it by operating in a different regime, than that required by the cited reference. Accordingly, claims 10-16 and 23-24 are not obvious over the Finn reference.

The Office Action also stated (pg. 7): "One of skilled in the Art would understand that making something thicker makes it stronger, but also increases its conductivity."

However, in the present case, Applicants are doing the opposite of what is suggested by the Examiner-i.e., Applicants increase the electrolyte sheet conductivity (improving the ohmic resistance of the electrolyte sheet) by reducing the average electrolyte sheet thickness.

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**Conclusion**

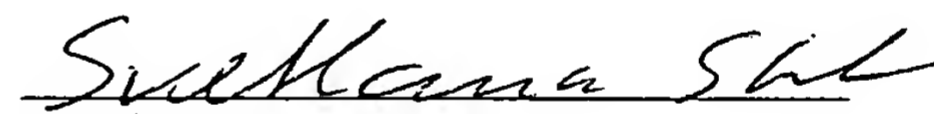
Based upon the above amendments, remarks, and papers of records, applicant believes the pending claims of the above-captioned application are in allowable form and patentable over the prior art of record. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Applicant believes that no extension of time is necessary to make this Reply timely. Should applicant be in error, applicant respectfully requests that the Office grant such time extension pursuant to 37 C.F.R. § 1.136(a) as necessary to make this Reply timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Svetlana Z. Short at 607-974-0412.

Respectfully submitted,

DATE: 10 - 31 - 06

  
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